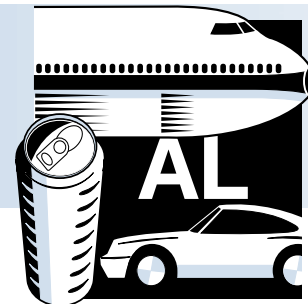


ALUMINUM

Project Fact Sheet



IN-SITU GRAIN REFINEMENT PROCESS FOR ALUMINUM

BENEFITS

Potential benefits of the in-situ process that requires commercial demonstration include:

- \$14 million annual cost savings resulting from the lower cost of grain refinement
- Energy savings of 2 trillion Btu annually
- Eliminating millions of pounds of spent salt annually
- Higher furnace productivity
- Reduced process scrap

APPLICATIONS

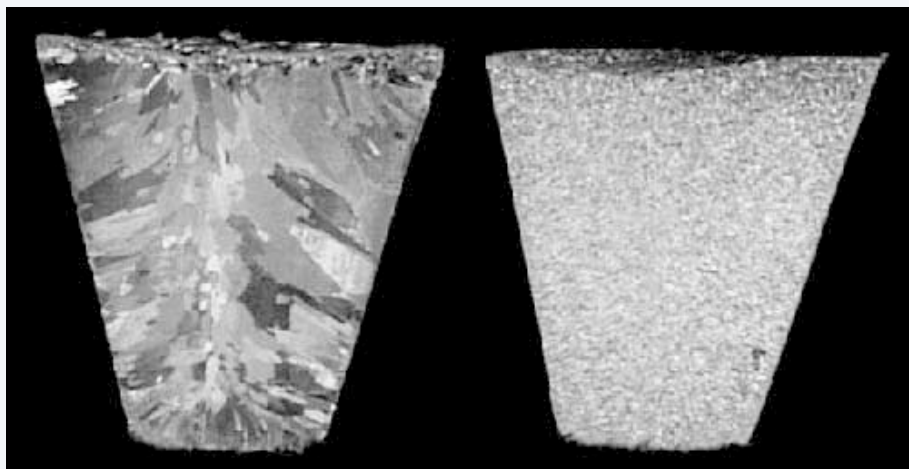
The in-situ process can be used as an effective way to grain refine aluminum castings and offers significant cost, energy and environmental benefits. The new process can be applied worldwide, since almost all aluminum alloys need to be grain refined.

NEW EFFECTIVE METHOD WILL PRODUCE CLEANER, HIGHER-QUALITY ALUMINUM CASTINGS

A new method of grain refining aluminum employing the in-situ formation of boride nuclei in molten aluminum has been developed and tested (U.S.P.#5,935,295). This method produces nuclei that are more uniform in size and are simpler to prepare than conventional grain refiners. Replacing conventional master alloy rod refiners provides energy, capital and environmental savings. Grain refining improves many metallurgical properties such as resistance cracking, ductility and surface finishing characteristics. Almost all aluminum cast is grain refined with titanium boride (TiB_2) nuclei. Trace amounts of titanium are inherent in molten aluminum. In this new process, boron readily reacts with titanium to form insoluble TiB_2 nucleation sites for the production of fine grains.

In the U.S., the production of master alloy grain refiners in the form of rod consumes nearly 10 million pounds of aluminum and generates 2.8 million pounds of spent salts annually. Current grain refiners are master alloys of aluminum containing micron-sized TiB_2 nuclei which are dispersed as the rod melts into the molten aluminum metal just prior to casting. Rod refiners can introduce impurities and/or nuclei agglomerates that give rise to defects in aluminum products. The in-situ method of refining introduces fine bubbles of boron trichloride gas directly into the molten metal. The gas is absorbed and the boron combines with titanium and other solute metals to form the nuclei necessary for fine grain growth.

ALUMINUM GRAIN REFINEMENT



Grain structure observed before and after in-situ nuclei formation.



Project Description

Goals: Project partners tested and demonstrated a new commercially viable in-situ grain refiner.

Boron trichloride gas is readily absorbed into molten aluminum. The boron reacts with dissolved titanium to form insoluble nuclei for grain refinement. Project partners developed a method of introducing boron trichloride into molten aluminum as small well-dispersed bubbles that are absorbed and form solid nuclei for grain refining.

The in-situ process injects boron trichloride carried in an argon gas stream directly into the molten aluminum. This produces the very fine boride nuclei necessary for grain refinement. Introducing the refiner, as a gas is compatible with current in-line metal treatment practices commonly used for hydrogen reduction and replaces chlorine used for sodium, calcium and enhanced oxide reduction in molten aluminum.

Present solid grain refiners are composed of materials that require multi-step processes to produce and involve the reduction of salts with aluminum. For each pound of refiner about 0.28 pounds of spent salt (a potassium aluminum fluoride) is produced. Boron trichloride gas is simple to produce and lower in cost. It provides grain refining in aluminum with simpler overall manufacturing requirements, with environmental, capital and power savings and produces nuclei of uniform size without agglomeration or other solid refiner impurities.

Progress and Milestones

This project was completed in 2000. In foundry alloys, the in-situ process allows grain refining to be roughly equivalent to the best commercial grain refiners. The process was demonstrated in commercial pilot equipment at the Reynolds Metals Research and Development Center in Chester, VA and is ready for commercial demonstration.

The in-situ process produced a more uniform size of boride nuclei than rod refiners did. This study demonstrated that the nuclei size produced in this process does not have measurable affect on grain refiner performance.

At the present stage of development, the in-situ process has not been able to consistently equal the grain refining performance of commercial grain refiners in wrought alloys. The process does work for all major aluminum alloys, except those containing significant levels of zirconium, and when incrementally improved, it will offer economic and quality advantages to the wrought aluminum industry.

Commercialization Plan

The in-situ process is commercially available for foundry alloys. Additional improvements to the technology will permit commercialization in the wrought aluminum industry.



PROJECT PARTNERS

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